Review

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Appendiceal Intussusception

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ABSTRACT The pathology of the appendix remains one of the topical areas of abdominal surgery. Its rare diseases can be difficult to diagnose and treat, and are accompanied by the development of serious complications. One of them is intussusception of the appendix to the cecum. Intussusception can be caused by previously undiagnosed primary lesions of the appendix. At the same time, it can simulate tumor and tumor-like formations of the cecum and lead to diagnostic errors. The literature review provides modern data on the history of the study of the problem, the epidemiology of classification, the causes and mechanisms of the development of appendiceal intussusception, the methods of its diagnosis and treatment.

Keywords: appendix, intussusception, appendicitis, cecum, tumor, appendectomy

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VAI – vermiform appendix invagination
VA – vermiform appendix

INTRODUCTION.

Vermiform appendix invagination (VAI) as the primary problem connected with anatomic features of the vermiform appendix (VA), its motor activity, as well as the secondary problem connected with the number of benign neoplasms and malignant formations in the VA itself and ileocecal area, is not enough studied and highlighted in the medical literature.

According to the P.F. Kaliteevskiy expression “vermiform appendix non-inflammatory diseases have vanished in the flow of appendicitis» (1). However along with different forms of appendicitis, benign neoplasms and malignant formations, parasitic diseases there is a number of pathologic processes that may lead to serious complications and are of great difficulty for pre-operational diagnostics and surgical treatment tactics choice.

Authors did not aim at choosing all publications from all available sources depicting single VAI, the review is based on previously published summarized data depicting not less than 5 cases.

EPIDEMIOLOGY, ETIOLOGY AND PATHOGENESIS

Intussusception of the appendix is a rather rare surgical pathology. According to the available domestic and foreign literature, among all cases of intestinal obstruction, VAI occurs in 3-4% [1-11].

The invagination of the appendix was first described by McKidd in 1858 as an autopsy finding in a seven-year-old boy [12]. In the next century and a half, publications with a description of single or small series (no more than 5 cases) predominate, and most of the publications highlight cases of associated (secondary) VAI associated with the presence of various pathologies, including tumors of the VA [13–21].

Publications on intussusception of a "healthy" appendix by the type "into itself" are sporadic [2–5, 7–10, 12, 22–25].

In this regard, a clear separation of primary and secondary intussusceptions is necessary.

The etiology of primary VAIs in most cases remains unknown. However, some features have been identified that predispose to the development of intussusception; they are represented by two groups: anatomical and pathological [1, 3].

Anatomical conditions:

- fetal type of cecum with an appendix in the region of the apex of its dome;
- an increase in the diameter of the lumen of the appendix with a large lumen of the proximal part in comparison with the distal one;
- a thin mesentery of the VA with a reduced volume of fiber and a narrow base.

Pathological conditions are associated with abnormal peristalsis of the appendix due to its irritation. The ability to self-peristalsis of the VA was radiologically determined by S.P. Grigoriev [1]. Its longitudinal musculature reacts to acetylcholine with tonic contractions, annular - periodic, while the longitudinal is more powerful and excitable. Thus, both intramural and intraluminal stimulants irritate and activate the VA peristalsis, which leads to the appearance of the intussusception onset point in a certain part of the wall, pulling the rest of the VA. Such areas are called "leading points", which are then retracted into the lumen of the VA or the dome of the cecum by peristalsis, which is the main mechanism of primary intussusception [1, 11].

Secondary intussusceptions are associated with the presence of a pathological focus in the VA itself, which is the leading factor [3, 11, 15, 16, 19, 20, 26-29].

Tumors of the VA amount to 0.5% of all tumors of the gastrointestinal tract, half of them are described in the literature as the leading item in the AVI [3, 11, 15, 19, 20].

For the first time, adenocarcinoma of VA was described by Berger (1882), endometriosis - by K. Rokitansky (1860), and in Russia - by F.K. Weber (1907) [1].

In 1963, D. Collins published the results of a study of 71 thousand observations of various pathologies of VA for 40 years, while the frequency of intussusceptions was 0.01%, endometriosis as the leading item was noted in 0.05%, adenocarcinoma of VA in 0.08% of cases [6].

Costa et al. in 2014 analyzed 194 secondary VAI cases published in the PubMed database from 1925 to 2012 using the keywords "appendix intussusception", "appendiceal intussusception", "intussuscepted AND appendix" and "appendiceal AND intussuscepted" [30].

In the most complete, of the latest literary reviews (2017), devoted to a greater extent to secondary VAIs, it is noted that most often (28%) the role of the leading point of intussusception is played by acute inflammation of the VA (acute appendicitis) [11].

The next common cause was endometriosis, which was diagnosed in 23.6% of patients. Mucocele as the leading point of VAI was observed in 15.9%, mucinous cystadenomas - in 4.4%, adenomas - in 7.7%, adenocarcinomas - in 4.4%, carcinoid tumors - in 4.9% and in one case (0.55%) diagnosed with neuroendocrine cancer with metastases to the lymph nodes.

Other tumors of the invaginated appendix are, in one example, papilloma, hamartoma, juvenile polyp, MALT lymphoma, and ileocecal non-Hodgkin's lymphoma. In total, 74 patients (40.6%) had benign or malignant tumors. In this study, on the basis of 220 cases of VAI described in the literature, its gender characteristics are given, men accounted for 37.6%, women - 62.4%. Pediatric cases accounted for 23.8%, adult patients - 76.2% [11].

The classification and types of VAI proposed by V. McSwain in 1941, with some additions, are still relevant and generally accepted [12].

Type I: the apex of the appendix forms the invaginate and penetrates into its proximal part.

Type II: intussusception begins in some part of the appendix. The cavity for the invaginate is formed by the adjacent tissues.

Type III: intussusception begins at the junction of the appendix with the cecum [31].

Type IV: retrograde invagination, in which the proximal part is invaginated into the distal one.

Type V: complete intussusception as a result of progression of type 1, type 2, or type 3 intussusception.

"itself to itself" intussusception is less common than others [1–4]. D. Collins, as a result of a study of 71 thousand VA after appendectomy, only in one case revealed this type of VAI [6]. P.F. Kaliteevsky and K.S. Rukosuev in the 70s. of the last century, when describing their VAI observations report five published cases of "itself to itself" VAI [1, 4]. In the available literature for 10 years, we found 14 descriptions of this type of invagination [2–5, 7, 9, 10, 12, 15, 22–25, 32].

Langsam et al. in 1984 described in detail the mechanisms of formation of an isolated VAI, taking into account the localization of the leading point [33]:

1. The head of the invaginate is the apex of the appendix:
    1.1. The head of the invaginate is introduced into the lumen of the appendix to different depths, not reaching its base.
    1.2. The head of the invaginate is inserted up to the cavity of the cecum. In this case, as in the previous one, the apex of the appendix is in the invaginate, the size of the visible part of the VA decreases.
    1.3. The head of the invaginate, moving forward, is introduced into the cavity of the cecum, while the appendix is turned out like a finger of a glove.

The dome of the cecum, as a rule, is not involved in invaginate.

The formation of a small funnel-shaped retraction of the dome of the cecum in the circumference of the base of the appendix is possible.

2. The head of the invaginate is the proximal part of the appendix:
    2.1. The head of the invaginate is located closer to the base of the VA, while the apex of the appendix remains outside the invaginate.
    2.2. With deep penetration of the proximal part of the appendix, the VA can completely disappear into the invaginate.
    2.3. When the VA is introduced from the base, the head of the invaginate immediately appears in the cavity of the cecum, and the apex of the appendix may remain outside the invaginate.
    2.4. With further advancement of the head of the invaginate, the VA may completely appear in the lumen of the invaginate. In this case, the dome of the cecum in the circumference of the base of the appendix is often drawn into the cavity of the cecum, forming a funnel-shaped retraction.

With all variants of the introduction of VA through its lumen into the cavity of the cecum, it is turned by the mucous membrane outward like a glove finger and is located in the cecum like a bell tongue. In other types of intussusception (ileocecal, blind-colon), the process is passively involved in the invaginate and remains non-inverted [33].

DIAGNOSTICS

Preoperative diagnosis of VAI is extremely difficult, and the diagnosis, as a rule, is intraoperative when VAI is combined with destructive appendicitis [1, 3-5, 7, 10, 20, 22, 32, 34, 35].

It is also difficult to determine the cause and type of VAI preoperatively, although the tactics and volume of surgical intervention depend on this.

However, in the publication of Tsukamoto R. et al., in 32% of cases before the operation, a disease was detected, which led to a secondary VAI [36].

Ultrasonography plays an important role as a diagnostic tool for VAI. Sonographic features include multiple concentric hyperechoic and hypoechoic rings. Ultrasound examination of the abdominal cavity allows to identify the “target feature”, the concentric ring as part of the appendix topography, which practically confirms the diagnosis of VAI [35, 37].

Visualization of the VA pathology during irrigoscopy plays an important role, however, anatomical features and nonspecific radiological symptoms can make it difficult to accurately determine the presence or absence of VA pathology. A number of studies have noted that the appearance of a "twisted spring" in the dome of the cecum with non-filling of the lumen of the VA with tight filling of the cecum with barium suspension is a sign of a clear or proven VAI [30, 37, 38].

Computed tomography of the abdominal cavity is the most commonly used method for diagnosing VAI. The wall of the cecum, due to repeated invaginations, undergoes inflammation and fibrosis, which leads to the formation of a mass-like formation. The presence of a concentric central mass, a "target sign," having a layered, sausage-like or kidney-like appearance, is an almost pathognomonic sign of VAI in computer diagnostics [30, 35, 37, 38].

Colonoscopy allows direct visualization of the lesion, while the invaginated appendix looks like a polypoid formation covered with a normal mucous membrane, in the form of an adenomatous polyp with a central retraction in the anatomical place of the VA, or a long invaginated tubular structure ("bell tongue") protruding from the appendicular opening into the lumen of the cecum [39, 40].

TREATMENT

The invagination of the appendix in 63% has a chronic form, casuistic cases of spontaneous disinvagination of the VA have been described, there are reports of regression of invagination and clinical symptoms after a barium enema. Nevertheless, the risk of recurrence is high and most surgeons advocate surgical treatment [1, 9, 41].

Some surgeons recommend appendectomy in conjunction with resection of the caecum cuff around the base of the VA. In their opinion, the advantage of this method is to eliminate the risk of failure of the VA stump, resection of the cecum cuff provides reliable closure of the resulting wound defect of its dome.

Since most lesions of the VA are benign, cuff resection together with appendectomy provides complete cure [1, 9, 21, 35, 37, 38, 41–43].

Not a single method for diagnosing ICO currently allows solving the main question, whether the process is benign or malignant, since intussusception forms a tumor mass, its malignancy cannot be determined even during surgery. Until now, the basic principle of choosing the scope of the operation is the experience and oncological vigilance of the operating surgeon. If intussusception is misdiagnosed as an VA neoplasm before or during surgery, surgical treatment is performed as if the process is a malignant VA neoplasm.

If a mucous cyst or adenoma is the cause, appendectomy is appropriate. Carcinoid tumors and adenocarcinoma require right-sided hemicolectomy with lymphadenectomy [35, 36, 40].

There are no clear recommendations in the literature on the choice of the scope of surgical treatment.

Appendectomy is acceptable if the tumor process is located within the VA and can be completely removed. Right-sided hemicolectomy should be performed when the tumor infiltrate has spread to the dome of the cecum [37, 39, 41, 44].

According to Chaar C.I. et al. (2009), 49% of patients underwent simple appendectomy, 48% of patients underwent extended operations with resection of the dome of the cecum or hemicolectomy, laparoscopic appendectomy was performed in 2% of cases [5].

Several case studies have reported the colonoscopic appendectomy using the Endoloop ligature [39, 40].

In a later study by Soylu L. et al. (2014) for the treatment of VAI : ileocecectomy (27%), right-sided hemicolectomy (21%) and subtotal colectomy (1%) are used. Colonoscopic appendectomy was performed in 4 patients (3%). This method is effective and safe if the endoscopist detects intussusception of the appendix without signs of tumor lesion [28].

The use of laparoscopic VAI surgery for tumor lesions of the VA remains a controversial issue. The main problem to be solved in this case is the adequacy of the resection volume depending on the spread of the tumor, especially in urgent surgery [39, 41].

In this regard, the reports that have appeared since the beginning of 2000 about significant advances in endoscopic, radiation and laparoscopic diagnostics of asymptomatic VAI deserve attention. Patients underwent various kinds of examinations in connection with recurrent non-localized pain in the abdomen, with transient disturbances of intestinal passage, or the presence of VAI was a diagnostic finding [2, 5, 8, 13-15, 17-19, 21, 24, 25, 32, 38, 43].

Expansion of diagnostic capabilities, the absence of the need for an emergency or urgent operation can make it possible to verify the nature of the process and select an adequate amount of operational aid.

CONCLUSION

Thus, the epidemiology of the vermiform appendix invagination based on intra-operative and in rare cases pre -operative diagnostics is doubtful, the spread of vermiform appendix invagination is much higher as in many cases it is asymptomatic.

Vermiform appendix invagination present variants and possibility of their combinations particularly during the asymptomatic course are difficult to diagnose and surgically treat in due time.

The material analysis makes us conclude that the modern diagnostics issue and particularly the problem of the adequate surgical vermiform appendix invagination treatment is surgery- relevant and requires tactics change. Most often the vermiform appendix invagination is the secondary pathology, associated with the primary ones including malignant diseases of the vermiform appendix. Both intra-operative diagnostics accuracy, and the degree of the tumor process spread impact the surgery tactics.

REFERENCES

1. Kaliteevskiy PF. *Bolezni cherveobraznogo otrostka*. Moscow: Meditsina Publ.; 1970. (in Russ.).
2. Davidovich TV, Karpenko EB, Mikhaylov IV, Kravtsov SA. Sluchay appendikotsekal'noy invaginatsii. *News of Beam Diagnostics Belarus*. 2000;2:34-35. (in Russ.)
3. Dolzhikov AA, Migunov AA, Lugovskoy SL. Acute Appendicitis in a Rare Variant of Invagination of the Vermiform Appendix. Case Report and Review of Literature. *Research Result. Medicine and Pharmacy*. 2017;3(3):3–11. https://doi.org/10.18413/2313-8955-2017-3-3-3-11 (in Russ.)
4. Rukosuev K.S. Redkiy sluchay invaginatsii cherveobraznogo otrostka. *Arkhiv Patologii.* 1962;2:80–82. (In Russ.)
5. Chaar CI, Wexelman B, Zuckerman K, Longo W. Intussusception of the appendix: comprehensive review of the literature. *Am J Surg*. 2009;198(1):122–128. PMID: 19249733. https://doi.org/10.1016/j.amjsurg.2008.08.023
6. Collins DC. 71.000 human appendix specimens. A final report, summarizing forty years' study. *Am J Proctol*. 1963;14:265–281. PMID: 14098730
7. Jevon GP, Daya D, Qizilbash AH. Intussusception of the appendix. A report of four cases and review of the literature. *Arch Pathol Lab Med*. 1992;116(9):960–964 PMID: 1524463
8. Ryu BY, Kim TH, Jeon JY, Kim HK, Choi YH, Baik GH. Colonoscopic diagnosis of appendiceal intussusception: a case report. *J Korean Med Sci*. 2005;20(4):680–682. PMID: 16100466 https://doi.org/10.3346/jkms.2005.20.4.680
9. Komine N, Yasunaga C, Nakamoto M, Shima I, Iso Y, Takeda Y et al., Intussusception of the appendix that reduced spontaneously during follow-up in a patient on hemodialysis therapy. *Intern Med*. 2004;43(6):479–483. PMID: 15283183 https://doi.org/10.2169/internalmedicine.43.479
10. Sousa M, Cotter J, Leão P. McSwain type V appendix intussusception. *BMJ Case Rep*. 2017;2017-219634. PMID: 28619971 https://doi.org/10.1136/bcr-2017-219634
11. Varsamis N, Pouggouras K, Salveridis N, Theodosiou A, Lostoridis E, Karageorgiou G, et al. Appendiceal Intussusception. In: Lule G. (ed.) *Current Concepts in Colonic Disorders*. London: InTech; 2012. p. 47–64. Available at: https://www.intechopen.com/books/current-concepts-in-colonic-disorders/appendiceal-intussusception [Accessed Apr 20, 2020].
12. M'Kidd J. Case of Invagination of the Cœcum and Appendix. *Edinb Med J.* 1859;4(9):793–796. PMID: 29648219
13. Nalivkin AE, Mashkov AE, Druzyuk EZ, Filyushkin YuN. Redkaya forma invaginatsii appendiksa v slepuyu kishku v sochetanii s ileotsekal'noy invaginatsiey kishechnika. *Russian Journal of Pediatric Surgery*. 2009;6:55–56. (In Russ.)
14. Akbayir N, Yildirim S, Sökmen HM, Kilic G, Erdem L, Alkim C. Intussusception of vermiform appendix with microscopic melanosis coli: a case report. *Turk J Gastroenterol*. 2006;17(3):233–235. PMID: 16941263
15. Chen YC, Chiang JM. Appendiceal intussusception with adenocarcinoma mimicking a cecal polyp. *Gastrointest Endosc*. 2000;52(1):130–131. PMID: 10882984 https://doi.org/10.1067/mge.2000.106673
16. Chua TC, Gill P, Gill AJ, Samra JS. Ileocecal Intussusception Caused by an Appendiceal Neoplasm. *J Gastrointest Surg*. 2016;20(4):867–868. PMID: 26831058 https://doi.org/10.1007/s11605-015-3037-3
17. Fernández-Rey CL, Costilla García S, Alvarez Blanco AM. Appendicular mucocele as cause of intestinal intussusception: diagnostic by computer tomography. *Rev Esp Enferm Dig*. 2010t;102(10):604–605. PMID: 21039071 https://doi.org/10.4321/s1130-01082010001000008
18. Nycum LR, Moss H, Adams JQ, Macri CI. Asymptomatic intussusception of the appen-dix due to endometriosis. *South Med J*. 1999;92(5):524–255. PMID: 10342903 https://doi.org/10.1097/00007611-199905000-00016
19. Salehzadeh A, Scala A, Simson JN. Appendiceal intussusceptions mistaken for a polyp at colonoscopy: case report and review of the literature. *Ann R Coll Surg Engl*. 2010;92(6):46–48. PMID: 20615304 https://doi.org/10.1308/147870810X12699662981591
20. Wang SM, Huang FC, Wu CH, Ko SF, Lee SY, Hsiao CC. Ileocecal Burkitt's lymphoma presenting as ileocolic intussusception with appendiceal invagination and acute appendicitis. *J Formos Med Assoc*. 2010;109(6):476–479. PMID: 20610150 https://doi.org/10.1016/S0929-6646(10)60080-0
21. Yang TW, Lin YY, Tsuei YW, Chen YL, Huang CY, Hsu SD. Successful management of adult lymphoma-associated intussusception by laparoscopic reduction and appendectomy. *World J Gastroenterol*. 2016;22(19):4781–4785. PMID: 27217710 https://doi.org/10.3748/wjg.v22.i19.4781

22. Orzikulov TS, Yakubov RA, Abdusalomov SA. Appendic-cecal invagination simulating acute appendicitis. *The bulletin of Emergency Medicine*. 2011;4:67–68. (In Russ.).
23. Dunavant D, Wilson H. Intussusception of the appendix, with complete inversion of the appendix and protrusion from the anus. *Ann Surg*. 1952;135(2):287–288. PMID: 14903858 https://doi.org/10.1097/00000658-195202000-00017
24. Ozuner G, Davidson P, Church J. Intussusception of the vermiform appendix: preopera-tive colonoscopic diagnosis of two cases and review of the literature. *Int J Colorectal Dis*. 2000;15(3):185–187. PMID: 10954193 https://doi.org/10.1007/s003840000225
25. Seddik H, Rabhi M. Two cases of appendiceal intussusception: a rare diagnostic pitfall in colonoscopy. *Diagn Ther Endosc*. 2011;2011:198984. PMID: 21603019 https://doi.org/10.1155/2011/198984
26. Lee DJ, Kim HC, Yang DM, Kim SW, Ryu JK, Won KY, et al. A case of intussuscep-tion of the appendix secondary to endometriosis: US and CT findings. *J Clin Ultrasound*. 2015;43(7):443–446. PMID: 24956121 https://doi.org/10.1002/jcu.22188
27. Quirante FP, Montorfano LM, Serrot F, Billington ME, Da Silva G, Lo Menzo E, et al. The case of the missing appendix: a case report of appendiceal intussusception at the site of co-lonic mullerianosis. *Gastroenterol Rep (Oxf)*. 2017;5(4):309–312. PMID: 26383877 https://doi.org/10.1093/gastro/gov041
28. Soylu L, Aydın OU, Aydın S, Özçay N. Invagination of the appendix due to endometri-osis presenting as acute appendicitis. *Ulus Cerrahi Derg*. 2014;30(2):106–108. PMID: 25931894 https://doi.org/10.5152/UCD.2013.19
29. Dainius E, Pankratjevaite L, Bradulskis S, Venskutonis D. Intussusception of the Ap-pendix and Ileum Endometriosis: A Case Report. *Visc Med*. 2016;32(3):211–213. PMID: 27493950 https://doi.org/10.1159/000445394
30. Costa M, Bento A, Batista H, Oliveira F. Endometriosis-induced intussusception of the caecal appendix. *BMJ Case Rep*. 2014;2014 bcr2013200098. PMID: 25477360 https://doi.org/10.1136/bcr-2013-200098
31. Fetisov NI, Maskin SS, Czjan' Ju. Isolated intussusception of the vermiform appendix in adults. *Herald of Surgical Gastroenterology*. 2019;1:12–14. (In Russ.).
32. Dickson-Lowe RA, Ibrahim S, Munthali L, Hasan F. Intussusception of the vermiform appendix. *BMJ Case Rep*. 2015;2015:bcr2014207584. PMID: 26184356 https://doi.org/10.1136/bcr-2014-207584
33. Langsam LB, Raj PK, Galang CF. Intussusception of the appendix. *Dis Colon Rectum*. 1984;27(6):387–392. PMID: 6734362 https://doi.org/10.1007/bf02553007
34. Gilpin D. Intussusception of the appendix. *Ulster Med J*. 1989;58(2):193–195. PMID: 2603275
35. Park BS, Shin DH, Kim DIl, Son GM, Kim HS. Appendiceal intussusception requiring an ileocecectomy: a case report and comment on the optimal surgery. *BMC Surg*. 2018;18(1):48. PMID: 30068337 https://doi.org/10.1186/s12893-018-0380-9
36. Tsukamoto R, Sakamoto K, Honjo K, Niwa K, Sugimoto K, Ishiyama S, et all. Case of idiopathic and complete appendiceal intussusception. *Asian J Endosc Surg*. 2018;11(3): 256–258. PMID: 29214746 https://doi.org/10.1111/ases.12442
37. Laalim SA, Toughai I, Benjelloun el B, Majdoub KH, Mazaz K. Appendiceal intussus-ception to the cecum caused by mucocele of the appendix: Laparoscopic approach. *Int J Surg Case Rep*. 2012;3(9):445–447. PMID: 22706297 https://doi.org/10.1016/j.ijscr.2012.04.019
38. Haug J, Katkar AS, Covelli J. Appendiceal Intussusception Mimicking Cecal Mass and Fecal Matter: A Report of Two Rare Cases. *Case Rep Radiol*. 2018;2018:4809650. PMID: 30112244 https://doi.org/10.1155/2018/4809650
39. Burchard PR, Thomay AA. Appendiceal intussusception in the setting of ulcerative colitis. *J Surg Case Rep*. 2018;2018(4):rjy044. PMID: 29644035 https://doi.org/10.1093/jscr/rjy044
40. Hammoud GM, Quick J, Samiullah S, Rao D, Ibdah JA. Endoscopic full-thickness resection of a long intussuscepted appendix by use of a colonoscope. *VideoGIE*. 2018;4(1):34–36. PMID: 30623159. https://doi.org/10.1016/j.vgie.2018.10.001
41. Birriel TJ, Smith E, Eyvazzadeh D. Appendiceal intussusception from endometriosis: endoscopic and laparoscopic approach. *Ann R Coll Surg Engl*. 2017;99(1):e1–e2. PMID: 27551900 https://doi.org/10.1308/rcsann.2016.0244
42. Leshchinskiy S, D'Agostino R. The coiled spring sign of appendiceal intussusception. *Abdom Radiol (NY)*. 2018;43(9):2539–2541. PMID: 29453516 https://doi.org/10.1007/s00261-018-1506-3
43. Tăban S, Dema A, Lazăr D, Sporea I, Lazăr E, Cornianu M. An unusual "tumor" of the cecum: the inverted appendiceal stump. *Rom J Morphol Embryol*. 2006;47(2):193–196. PMID: 17106530
44. Atkinson GO, Gay BB Jr, Naffis D. Intussusception of the appendix in children. *AJR Am J Roentgenol*. 1976;126(6):1164–1168. PMID: 179374 https://doi.org/10.2214/ajr.126.6.1164

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